PATENT APPLICATION

THE UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE HONORABLE BOARD OF PATENT APPEALS AND INTERFERENCES

In re the Application of

J. VAN DEN BRINK

Application No.: 10/595,273 Examiner: T. Fetzner

Filed: April 4, 2007 Docket No.: PHNL031200US
PKRZ 2 01151

For: SYSTEM AND METHOD FOR MAGNETIC RESONANCE IMAGING

# BRIEF ON APPEAL

Appeal from Group 2859

Thomas E. Kocovsky, Jr., Esq.
Reg. No. 28,383
Robert M. Sieg
Reg. No. 54,446
FAY SHARPE LLP
1100 Superior Avenue – Seventh Floor
Cleveland, Ohio 44114-2579
Telephone: (216) 861-5582
Attorneys for Appellants

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| Date: January 8, 2008 | Name: Patricia A. Heim |

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## I. REAL PARTY IN INTEREST

The real party in interest for this appeal and the present application is Koninklijke Philips Electronics N.V., by way of an Assignment recorded in the U.S. Patent and Trademark Office at Reel 017418, Frame 0540.

## II. RELATED APPEALS AND INTERFERENCES

There are no prior or pending appeals, interferences or judicial proceedings, known to Appellant, Appellant's representative, or the Assignee, that may be related to, or which will directly affect or be directly affected by or have a bearing upon the Board's decision in the pending appeal.

## III. STATUS OF CLAIMS

Claims 1-18 are on appeal.

Claims 1-18 are pending.

Claims 1-18 are rejected.

No claims have been cancelled.

## IV. STATUS OF AMENDMENTS

No Amendment After Final Rejection has been filed.

V. SUMMARY OF CLAIMED SUBJECT MATTER

The invention of claim 1 is directed to a magnetic resonance imaging system comprising: an acquisition module (7) configured for acquiring first magnetic resonance signals (8) for a central portion of k-space using a first magnetic resonance frequency and for acquiring second magnetic resonance signals (10) for a peripheral portion of k-space using a second magnetic resonance frequency different from the first magnetic resonance frequency; a data module (3) configured for combining (12) first k-space data corresponding to the first magnetic resonance signals and second k-space data corresponding to the second magnetic resonance signals to form a full k-space; and an image module (3) configured for generating (13) an image by transformation of the full k-space to image space.

The invention of claim 6 is directed to the invention of claim 1, further limited in that the acquisition module for acquiring first magnetic resonance signals are configured to acquire signals from non-proton nuclei [page 3 lines 21-26].

The invention of claim 7 is directed to the invention of claim 6, further limited in that the acquisition module for acquiring first magnetic resonance signals are configured to acquire signals from hyperpolarized non-proton nuclei [page 3 lines 21-26].

The invention of claim 8 is directed to the invention of claim 1, further limited in that the acquisition module for acquiring first magnetic resonance signals are configured to acquire signals from electron spins [page 4 lines 25-34].

The invention of claim 11 is directed to a magnetic resonance imaging method comprising: acquiring (8) first magnetic resonance signals for a central portion of k-space using a first magnetic resonance frequency; acquiring (10) second magnetic resonance signals for a peripheral portion of k-space using a second magnetic resonance frequency different from the first magnetic resonance frequency; combining (12) the first k-space data corresponding to the first magnetic resonance signals and the second k-space data corresponding to the second magnetic resonance signals to form a full k-space; and generating (13) an image by transformation of the full k-space to image space.

The invention of claim 12 is directed to a carrier or memory storing a computer program executable by a computer [page 6 lines 18-27] to perform a method comprising: acquiring (8) first magnetic resonance signals for a central portion of k-space using a first magnetic resonance frequency; acquiring (10) second magnetic resonance signals for a peripheral portion of k-space using a second magnetic resonance frequency different from the first magnetic resonance frequency; combining (12) the first k-space data corresponding to the first magnetic resonance signals and the second k-space data corresponding to the second magnetic resonance signals to form a full k-space; and generating (13) an image by transformation of the full k-space to image space.

The invention of claim 13 is directed to the invention of claim 1, further limited in that the acquisition module is configured to acquire the first magnetic resonance signals from a first nuclear species and to acquire the second magnetic resonance signals from a second nuclear species different from the first nuclear species [page 3 line 21 to page 4 line 26].

The invention of claim 14 is directed to the invention of claim 1, further limited in that the acquisition module is configured to acquire the first magnetic resonance signals from a first nuclear species other than the $^1H$ nuclear species and to acquire the second magnetic resonance signals from the $^1H$ nuclear species [page 3 lines 21 to page 4 line 14].

The invention of claim 15 is directed to the invention of claim 1, further limited in that the acquisition module is configured to acquire the first magnetic resonance signals from electron spins and to acquire the second magnetic resonance signals from the $^1H$ nuclear species [page 4 lines 25-34].

The invention of claim 16 is directed to the invention of claim 11, further limited in that the first magnetic resonance signals are from a first nuclear species and the second magnetic resonance signals are from a second nuclear species different from the first nuclear species [page 3 line 21 to page 4 line 26].

The invention of claim 17 is directed to the invention of claim 11, further limited in that the first magnetic resonance signals are from a nuclear species other than

the $^1H$ nuclear species, and the second magnetic resonance signals are from the $^1H$ nuclear species [page 3 lines 21 to page 4 line 14].

The invention of claim 18 is directed to the invention of claim 11, further limited in that the first magnetic resonance signals are from electron spins and the second magnetic resonance signals are from the $^1H$ nuclear species [page 4 lines 25-34].

## VI. GROUNDS OF REJECTION TO BE REVIEWED ON APPEAL

The following grounds of rejection are presented for review:

1) Whether claims 1-12 are properly objected to as indefinite;

2) Whether claims 1-5 and 9-12 are properly rejected as anticipated under 35 U.S.C. §102(e) by Moriguchi et al., U.S. Pat. No. 7,042,215;

3) Whether claims 1-5 and 9-12 are properly rejected as anticipated under 35 U.S.C. §102(e) by Haase et al., U.S. Pat. No. 6,400,151;

4) Whether claims 6 and 8 are properly rejected as unpatentable over Haase et al., U.S. Pat. No. 6,400,151 in view of Van Den Brink et al., U.S. Publ. Appl. No. 2003/0122545 A1;

5) Whether claims 6 and 8 are properly rejected as unpatentable over Haase et al., U.S. Pat. No. 6,400,151 in view of Van Den Brink et al., U.S. Pat. No. 6,593,740;

6) Whether claims 6 and 7 are properly rejected as unpatentable over Haase et al., U.S. Pat. No. 6,400,151 in view of Salerno et al., U.S. Publ. Appl. No. 2004/0260173 A1;

7) Whether claims 6 and 7 are properly rejected as unpatentable over Moriguchi et al., U.S. Pat. No. 7,042,215 in view of Salerno et al., U.S. Publ. Appl. No. 2004/0260173 A1; and

8) Whether claims 13-18 are properly rejected as unpatentable under § 103(a), where a relied-upon combination of references is not explicitly stated in the Office Action, but only Haase et al., U.S. Pat. No. 6,400,151 is mentioned in the written explanation of the rejections of claims 13-18.

VII. ARGUMENT

**A. Claims 1-12 are not indefinite.**

The objected term "magnetic resonance frequency" is well known in the magnetic resonance imaging art, and is used in its usual manner in the application and claims. It is not a difficult term to understand: a magnetic resonance frequency is the frequency at which a particle (i.e., nuclei or electron) resonates, i.e. the frequency of electromagnetic radiation emitted by the resonating particle.

Consider claim 1, for example, which calls for acquiring first magnetic resonance signals for a central portion of k-space using a first magnetic resonance frequency and for acquiring second magnetic resonance signals for a peripheral portion of k-space using a second magnetic resonance frequency different from the first magnetic resonance frequency. The skilled artisan would have no difficulty in understanding this. First magnetic resonance signals are acquired for a central portion of k-space using a first magnetic resonance frequency, and second magnetic resonance signals are acquired for a peripheral portion of k-space using a second magnetic resonance frequency different from the first magnetic resonance frequency.

By way of example (and without limiting the scope of claim 1) one possible embodiment on which claim 1 may read is an acquisition in which the acquisition module acquires first magnetic resonance signals corresponding to the $^{19}F$ nuclear species for a central portion of k-space using a first magnetic resonance frequency (e.g., about 45 MHz for $^{19}F$ at 1.5T) and acquires second magnetic resonance signals corresponding to the $^{1}H$ nuclear species for a peripheral portion of k-space using a second magnetic resonance frequency (e.g., about 64 MHz for $^{1}H$ at 1.5T) which is different from the first magnetic resonance frequency.

The Office Action objects to the use of the conventional term "magnetic resonance frequency" as allegedly ambiguous:

> In independent claims 1, 11, and 12, while it is clear that there are two frequencies being employed by applicant, in applicants k-space acquisition, it is unclear as to whether these frequencies are part of a single pulse sequence, where the frequency changes during a single acquisition as in the case of

> the variable density spiral acquisitions of the cited prior arts of record below, or whether a first portion/segment/sequence is performed at a first frequency followed by a second portion/segment/sequence being performed between which time the first frequency is changed, as in Haase et al., prior art applied below. Due to the confusion, over the scope of applicant's invention in this respect, multiple rejections based on the different potential interpretations are provided below. Appropriate correction (i.e. an amendment clarifying if the frequency change of the invention occurs within a single acquisition sequence, or between separate or repeated acquisition in a multiply portioned/multiply segmented, or multiple acquisition sequence;) is required.
>
> Office Action at page 2.

This exposition of the objection fails to mention the objected claim term "magnetic resonance frequency" and instead substitutes the different term "frequency" – which might indeed be ambiguous if that term was actually used in the claims – and objects that this substitute term "frequency" is ambiguous. The objection then goes on to require Applicants to amend the claims to clarify the alleged ambiguity.

The Office Action asks "whether these frequencies are part of a single pulse sequence, where the frequency changes during a single acquisition as in the case of the variable density spiral acquisitions." A variable density acquisition implies a variable sampling rate, i.e. variable sampling frequency. A sampling frequency is <u>not</u> a magnetic resonance frequency. These are totally different concepts – the skilled artisan could not possibly confuse "magnetic resonance frequency" for a frequency of variable density spiral acquisitions. The Office Action further asks "whether a first portion/segment/sequence is performed at a first frequency followed by a second portion/segment/sequence being performed between which time the first frequency is changed." Respectfully, Applicants do not understand this query.

It is respectfully submitted that the term "magnetic resonance frequency" would be unambiguous to the skilled artisan. Accordingly, Applicants respectfully request that the objection to claims 1-12 be reversed.

**B. Claims 1-5 and 9 and 10 are not anticipated by under 35 U.S.C. §102(e) by Moriguchi et al., U.S. Pat. No. 7,042,215.**

Moriguchi discloses a technique for imaging including fat/water decomposition and spiral k-space sampling. As described starting at col. 9 and referencing Figs. 5a and 5b, Moriguchi teaches collecting spiral data with oversampling in the central region. Different spiral trajectories employ different echo times (TE), and the data acquired with different TE are reconstructed into corresponding images of different echo time. A $B_0$ inhomogeneity field map is calculated by taking the phase differences of the different TE images. Water/fat decomposition and k-space data demodulation are performed for the low spatial frequency data, based on the frequencies indicated in the frequency field map.

Applicants find no suggestion in Moriguchi of collecting a central portion of k-space using a first magnetic resonance frequency and collecting a peripheral portion of k-space using a second magnetic resonance frequency different from the first magnetic resonance frequency. Rather, all data are collected at the same magnetic resonance frequency throughout k-space, using a receiver bandwidth large enough to encompass both the water and fat signals. Post-acquisition processing is then used to decompose the acquired magnetic resonance data into fat and water images.

A claim is anticipated only if each and every element as set forth in the claim is found, either expressly or inherently described, in a single prior reference. MPEP § 2131. Moriguchi does not anticipate an acquisition module configured for acquiring first magnetic resonance signals for a central portion of k-space using a first magnetic resonance frequency and for acquiring second magnetic resonance signals for a peripheral portion of k-space using a second magnetic resonance frequency different from the first magnetic resonance frequency. Rather, Moriguchi acquires both fat and water magnetic resonance frequencies using a broad bandwidth receiver for <u>all</u> of k-space. Moriguchi also does not anticipate a data module configured for combining first k-space data corresponding to the first magnetic resonance signals and second k-space data corresponding to the second magnetic resonance signals to form a full k-space. To the contrary, the data processing of Moriguchi entails <u>decomposing</u> the fat and water data that are <u>already combined as acquired</u>.

Claims 2-5, 9, and 10 depend directly or indirectly from claim 1, and accordingly are also not anticipated by Moriguchi et al.

Accordingly, Applicants respectfully submit that claims 1-5 and 9 and 10 are not anticipated by under 35 U.S.C. §102(e) by Moriguchi et al., U.S. Pat. No. 7,042,215, and respectfully request reversal of the rejections of claims 1-5 and 9 and 10 as anticipated under § 102(e) by Moriguchi et al.

C. **Claim 11 is not anticipated by under 35 U.S.C. §102(e) by Moriguchi et al., U.S. Pat. No. 7,042,215.**

Claim 11 includes the limitations of acquiring first magnetic resonance signals for a central portion of k-space using a first magnetic resonance frequency; acquiring second magnetic resonance signals for a peripheral portion of k-space using a second magnetic resonance frequency different from the first magnetic resonance frequency; and combining the first k-space data corresponding to the first magnetic resonance signals and the second k-space data corresponding to the second magnetic resonance signals to form a full k-space. Again, Moriguchi et al. acquires <u>both</u> the fat and water signals <u>together</u> throughout k-space, and then <u>decomposes</u> the signals. Thus, Moriguchi et al. does not combine first k-space data corresponding to first magnetic resonance signals and second k-space data corresponding to second magnetic resonance signals to form a full k-space, as called out in claim 11.

Accordingly, Applicants respectfully submit that claim 11 is not anticipated by under 35 U.S.C. §102(e) by Moriguchi et al., U.S. Pat. No. 7,042,215, and respectfully request reversal of the rejections of claim 11 as anticipated under § 102(e) by Moriguchi et al.

D. **Claim 12 is not anticipated by under 35 U.S.C. §102(e) by Moriguchi et al., U.S. Pat. No. 7,042,215.**

Claim 12 includes the mentioned limitations of claim 11 in the context of a computer program stored on a carrier or memory, and accordingly Moriguchi et al. also does not anticipate claim 12.

Accordingly, Applicants respectfully submit that claim 12 is not anticipated by under 35 U.S.C. §102(e) by Moriguchi et al., U.S. Pat. No. 7,042,215, and respectfully request reversal of the rejections of claim 12 as anticipated under § 102(e) by Moriguchi et al.

**E. Claims 1-5 and 9 and 10 are not anticipated under 35 U.S.C. §102(e) by Haase et al., U.S. Pat. No. 6,400,151.**

Haase identifies different regions of k-space using the Greek letter λ.

> In the upper left-hand diagram of FIG. 1a, the K-space is divided into three bands. The middle band of relative width λ is filled with the signals of the first sequence λ, and the two outer bands, which together make up the rest 1-λ of the total width 1, are filled with the signals of a second sequence j. The lower left-hand diagram of FIG. 1a shows a division into three bands with width ratios λ2: λ1:λ3 for three sequences I, j and k.
>
> Haase et al., U.S. Pat. No. 6,400,151 at col. 9 lines 31-38.

Thus, the Greek letter λ as used in Haase denotes widths of regions of k-space.

The Office Action misidentifies the various λ parameters of Haase et al. Fig. 1a as referring to different magnetic resonance frequencies:

> The examiner notes that every Magnetically resonant frequency that is detectable intrinsically has a corresponding wavelength and that the magnetic resonance frequency range of a given wavelength is the corresponding bandwidth for that intrinsically associated frequency range. Therefore, the presence of different multiple bandwidths, in Haase et al., [See col. 7 lines 61 through col. 8 line 4] indicate and imply that multiple magnetic resonance frequencies are present in the Haase et al., reference. See figures 1a, 1b, 1c, 1d, 4c].
>
> Office Action at page 6.

For electromagnetic radiation in free space every frequency has a corresponding wavelength, in accordance with the relationship frequency equals speed-of-light divided by wavelength. It is also true that the Greek letter λ is in some other contexts is used to indicate a wavelength.

But, Haase et al., expressly uses the parameter λ to denote the width of a region of k-space. Thus, for example, the annotation of λ1, ..., λ5 next to the upper center k-space map of Haase Fig. 1a does not denote that these five k-space regions are acquired using different magnetic resonance frequencies, but rather provides enumeration of the five k-space regions.

With the parameter λ correctly identified, it is evident that Haase et al. does not anticipate claim 1. Haase et al. does not disclose an acquisition module configured for acquiring first magnetic resonance signals for a central portion of k-space using a first magnetic resonance frequency and for acquiring second magnetic resonance signals for a peripheral portion of k-space using a second magnetic resonance frequency different from the first magnetic resonance frequency. Haase et al. further does not disclose a data module configured for combining first k-space data corresponding to the first magnetic resonance signals and second k-space data corresponding to the second magnetic resonance signals to form a full k-space.

In rejecting dependent claims 4 and 5, the Office Action at page 7 also cites the following passage of Haase et al.:

> Methods according to the invention can equally well be combined also with preliminary experiments for the T2-, T2*-, T1 weighting, or flow weighting or with preliminary experiments for the production of magnetisation transfer contrast (MTC) or with preliminary experiments for suppressing the water or fat components of a tissue. Such preliminary experiments are sufficiently known from the literature of this field not to need further explanation.
>
> Haase et al., U.S. Pat. No. 6,400,151 at col. 16 line 65 through col. 17 line 5.

Such weighting techniques relate to applying saturation prepulses and the like. This passage does not suggest, much less anticipate, limitations of claim 1 such as an acquisition module configured for acquiring first magnetic resonance signals for a central portion of k-space using a first magnetic resonance frequency and for acquiring second magnetic resonance signals for a peripheral portion of k-space using a second magnetic resonance frequency different from the first magnetic resonance frequency, or a data module configured for combining first k-space data corresponding to the first

magnetic resonance signals and second k-space data corresponding to the second magnetic resonance signals to form a full k-space.

Accordingly, Applicants respectfully submit that claims 1-5 and 9 and 10 are not anticipated by under 35 U.S.C. §102(e) by Haase et al., U.S. Pat. No. 6,400,151, and respectfully request reversal of the rejections of claims 1-5 and 9 and 10 as anticipated under § 102(e) by Haase et al.

F. **Claims 11 is not anticipated under 35 U.S.C. §102(e) by Haase et al., U.S. Pat. No. 6,400,151.**

Claim 11 calls for acquiring first magnetic resonance signals for a central portion of k-space using a first magnetic resonance frequency, acquiring second magnetic resonance signals for a peripheral portion of k-space using a second magnetic resonance frequency different from the first magnetic resonance frequency, and combining the first k-space data corresponding to the first magnetic resonance signals and the second k-space data corresponding to the second magnetic resonance signals to form a full k-space. Again, Haase et al. does not anticipate these limitations.

Accordingly, Applicants respectfully submit that claim 11 is not anticipated by under 35 U.S.C. §102(e) by Haase et al., U.S. Pat. No. 6,400,151, and respectfully request reversal of the rejections of claim 11 as anticipated under § 102(e) by Haase et al.

G. **Claims 12 is not anticipated under 35 U.S.C. §102(e) by Haase et al., U.S. Pat. No. 6,400,151.**

Claim 12 includes the limitations of claim 11 in the context of a computer program stored on a carrier or memory, and accordingly Haase et al. also does not anticipate claim 12.

Accordingly, Applicants respectfully submit that claim 12 is not anticipated by under 35 U.S.C. §102(e) by Haase et al., U.S. Pat. No. 6,400,151, and respectfully request reversal of the rejections of claim 12 as anticipated under § 102(e) by Haase et al.

**H. Claims 6-8 patentably distinguish over Haase et al., U.S. Pat. No. 6,400,151 in view of Van Den Brink et al., U.S. Publ. Appl. No. 2003/0122545 A1 or in view of Van Den Brink et al., U.S. Pat. No. 6,593,740 or in view of Salerno et al., U.S. Publ. Appl. No. 2004/0260173 A1.**

Claims 6-8 stand rejected under § 103(a) as allegedly unpatentable over the combination of Haase et al., U.S. Pat. No. 6,400,151 in combination with Van Den Brink et al., U.S. Publ. Appl. No. 2003/0122545 A1 or in view of Van Den Brink et al., U.S. Pat. No. 6,593,740 or in view of Salerno et al., U.S. Publ. Appl. No. 2004/0260173 A1.

In each of these proposed combinations, Haase et al. is relied upon to show the limitations set forth in base claim 1 of an acquisition module configured for acquiring first magnetic resonance signals for a central portion of k-space using a first magnetic resonance frequency and for acquiring second magnetic resonance signals for a peripheral portion of k-space using a second magnetic resonance frequency different from the first magnetic resonance frequency, and a data module configured for combining first k-space data corresponding to the first magnetic resonance signals and second k-space data corresponding to the second magnetic resonance signals to form a full k-space.

However, the different $\lambda$ parameters of Haase et al. are not indicative of different magnetic resonance frequencies, but rather index different regions of k-space. The additional references cited in combination with Haase et al. against claims 6-8 are cited to show acquisition of signals from non-proton nuclei or hyperpolarized non-proton nuclei or electron spins. Thus, these references cannot remedy the aforementioned deficiencies in Haase et al.

Accordingly, claims 6-8 distinguish patentably over the proposed combinations, and Applicants respectfully request reversal of the rejections of claims 6-8 based on Haase et al. in view of the cited secondary references.

### I. Claims 6 and 7 patentably distinguish over Moriguchi et al., U.S. Pat. No. 7,042,215 in view of Salerno et al., U.S. Publ. Appl. No. 2004/0260173 A1.

Claims 6 and 7 also stand rejected under § 103(a) as allegedly unpatentable over the combination of Moriguchi et al., U.S. Pat. No. 7,042,215 in view of Salerno et al., U.S. Publ. Appl. No. 2004/0260173 A1. In this proposed combination, Moriguchi et al. is relied upon to show the limitations set forth in base claim 1 of an acquisition module configured for acquiring first magnetic resonance signals for a central portion of k-space using a first magnetic resonance frequency and for acquiring second magnetic resonance signals for a peripheral portion of k-space using a second magnetic resonance frequency different from the first magnetic resonance frequency, and a data module configured for combining first k-space data corresponding to the first magnetic resonance signals and second k-space data corresponding to the second magnetic resonance signals to form a full k-space.

Moriguchi teaches acquiring both fat and water data simultaneously, using a sufficiently broad receiver bandwidth, for all of k-space. Moriguchi does not combine first k-space data corresponding to the first magnetic resonance signals and second k-space data corresponding to the second magnetic resonance signals to form a full k-space. Rather, the data processing of Moriguchi entails <u>decomposing</u> the fat and water data that are <u>already combined as acquired</u>. Thus, Moriguchi does not disclose or fairly suggest these limitations of base claim 1. Salerno et al. is cited to show acquisition of signals from non-proton nuclei or hyperpolarized non-proton nuclei, and thus cannot remedy these deficiencies in Moriguchi et al.

Accordingly, claims 6 and 7 distinguish patentably over the proposed combination, and Applicants respectfully request reversal of the rejections of claims 6 and 7 based on Moriguchi et al. in view of Salerno et al.

### J. Claims 13-18 patentably distinguish over Haase et al., U.S. Pat. No. 6,400,151.

It has already been argued herein that Haase et al. does not anticipate claims 1 and 11 which are base claims for claims 13-15 and 16-18, respectively. Once

Haase et al.'s $\lambda$ parameters are properly identified, it is also evident that Haase does not make obvious claims 1 and 11. Haase et al. discloses acquiring different regions of k-space using different sequences, but does not remotely suggest acquiring these different k-space regions using different magnetic resonance frequencies.

Accordingly, the limitations of the base claims 1 and 11, alone, are sufficient to patentably distinguish over Haase et al. However, it is respectfully submitted that claims 13-18 set forth further patentable distinctions over Haase et al.

Claim 13 depends from claim 1 and calls for the acquisition module to be configured to acquire the first magnetic resonance signals from a first nuclear species and to acquire the second magnetic resonance signals from a second nuclear species different from the first nuclear species. Claim 16 depends from claim 11 and calls for analogous method limitations.

Claim 14 depends from claim 1 and calls for the acquisition module to be configured to acquire the first magnetic resonance signals from a first nuclear species other than the $^1H$ nuclear species and to acquire the second magnetic resonance signals from the $^1H$ nuclear species. Claim 17 depends from claim 11 and calls for analogous method limitations.

Claim 15 depends from claim 1 and calls for the acquisition module to be configured to acquire the first magnetic resonance signals from electron spins and to acquire the second magnetic resonance signals from the $^1H$ nuclear species. Claim 18 depends from claim 11 and calls for analogous method limitations.

In Haase et al., the fat and water signals are both from the same nuclear species, namely the $^1H$ nuclear species. The difference in magnetic resonance frequencies is due to the chemical shift, i.e. due to the different chemical environment of the $^1H$ nuclear species in the respective fat and water matrices, and is miniscule, typically being of order a few parts-per-million (ppm) to perhaps a few tens of ppm. As a result, the approach of Haase can acquire both the fat and water signals as a single integrated signal using a magnetic resonance receiver having a bandwidth encompassing both the fat and water signals.

The magnetic resonance frequency for a given static ($B_0$) magnetic field is proportional to the gyrometric ratio. As noted in the present application, for example, the

gyrometic ratio for the $^{19}F$ nuclear species is 70% less than that of $^{1}H$, and 25% for $^{13}C$ and $^{129}Xe$. (Application at page 1 line 25). These differences translate to correspondingly large differences in magnetic resonance frequency of 25% or more, corresponding to differences in magnetic resonance frequency in the MHz to tens of MHz range. In contrast, the fat/water chemical shift for the $^{1}H$ magnetic resonance at 1.5 T is about 3.5 ppm which corresponds to about 224 Hz (that is, 0.000224 MHz).

Accordingly, even if Haase et al. were viewed as showing a combination of different k-space regions acquired using the fat and water signals, respectively (a view with which Applicants do not agree and argue against herein), such a result would still not provide the skilled artisan with a reasonable expectation of success in implementing the apparatuses of claims 13-15 or the methods of claims 16-18. Combining different k-space sampling regions acquired using two different chemically shifted magnetic resonance signals with magnetic resonance frequencies differing only by the chemical shift of about 3.5 ppm is not comparable with combining central and peripheral k-space regions acquired using different multi-nuclear magnetic resonance signals at nuclear magnetic resonance frequencies differing by amounts that are orders of magnitude larger than the chemical shift.

For at least the foregoing reasons, it is respectfully submitted that claims 13-18 distinguish patentably over Haase et al., and Applicants therefore respectfully request reversal of the rejections of claims 13-18 based on Haase et al.

## CONCLUSION

For all of the reasons discussed above, it is respectfully submitted that the rejections are in error and that claims 1-18 are in condition for allowance. For all of the above reasons, Appellants respectfully request this Honorable Board to reverse the rejections of claims 1-18.

Respectfully submitted,

Robert M. Sieg

Thomas E. Kocovsky, Jr.
Registration No. 28,383

Robert M. Sieg
Registration No. 54,446

: /

FAY SHARPE LLP
1100 Superior Avenue – Seventh Floor
Cleveland, Ohio 44114-2579
Telephone: (216) 861-5582

Filed:

## APPENDICES

VIII. CLAIMS APPENDIX

Claims involved in the Appeal are as follows:

1. A magnetic resonance imaging system comprising:

an acquisition module configured for acquiring first magnetic resonance signals for a central portion of k-space using a first magnetic resonance frequency and for acquiring second magnetic resonance signals for a peripheral portion of k-space using a second magnetic resonance frequency different from the first magnetic resonance frequency;

a data module configured for combining first k-space data corresponding to the first magnetic resonance signals and second k-space data corresponding to the second magnetic resonance signals to form a full k-space; and

an image module configured for generating an image by transformation of the full k-space to image space.

2. The system as claimed in claim 1, wherein the data module for combining first and second k-space data are configured to substitute the first k-space data for part of the second k-space data to form a full k-space.

3. The system as claimed in claim 1, wherein the data module for combining first and second k-space data are configured to add the first k-space data to the second k-space data to form a full k-space.

4. The system as claimed in claim 1, wherein the acquisition module for acquiring first magnetic resonance signals are configured to acquire signals from protons.

5. The system as claimed in claim 4, wherein the acquisition module for acquiring first magnetic resonance signals are configured to acquire signals from protons in another substance than $H_2O$.

6. The system as claimed in claim 1, wherein the acquisition module for acquiring first magnetic resonance signals are configured to acquire signals from non-proton nuclei.

7. The system as claimed in claim 6, wherein the acquisition module for acquiring first magnetic resonance signals are configured to acquire signals from hyperpolarized non-proton nuclei.

8. The system as claimed in claim 1, wherein the acquisition module for acquiring first magnetic resonance signals are configured to acquire signals from electron spins.

9. The system as claimed in claim 1, wherein the acquisition module for acquiring second magnetic resonance signals are configured to acquire signals from protons.

10. The system as claimed in claim 9, wherein the acquisition module for acquiring second magnetic resonance signals are configured to acquire signals from protons in $H_2O$.

11. A magnetic resonance imaging method comprising:

acquiring first magnetic resonance signals for a central portion of k-space using a first magnetic resonance frequency;

acquiring second magnetic resonance signals for a peripheral portion of k-space using a second magnetic resonance frequency different from the first magnetic resonance frequency;

combining the first k-space data corresponding to the first magnetic resonance signals and the second k-space data corresponding to the second magnetic resonance signals to form a full k-space; and

generating an image by transformation of the full k-space to image space.

12. A carrier or memory storing a computer program executable by a computer to perform a method comprising:

acquiring first magnetic resonance signals for a central portion of k-space using a first magnetic resonance frequency;

acquiring second magnetic resonance signals for a peripheral portion of k-space using a second magnetic resonance frequency different from the first magnetic resonance frequency;

combining the first k-space data corresponding to the first magnetic resonance signals and the second k-space data corresponding to the second magnetic resonance signals to form a full k-space; and

generating an image by transformation of the full k-space to image space.

13. The system as claimed in claim 1, wherein the acquisition module is configured to acquire the first magnetic resonance signals from a first nuclear species and to acquire the second magnetic resonance signals from a second nuclear species different from the first nuclear species.

14. The system as claimed in claim 1, wherein the acquisition module is configured to acquire the first magnetic resonance signals from a first nuclear species other than the $^1H$ nuclear species and to acquire the second magnetic resonance signals from the $^1H$ nuclear species.

15. The system as claimed in claim 1, wherein the acquisition module is configured to acquire the first magnetic resonance signals from electron spins and to acquire the second magnetic resonance signals from the $^1H$ nuclear species.

16. The magnetic resonance imaging method as claimed in claim 11, wherein the first magnetic resonance signals are from a first nuclear species and the second magnetic resonance signals are from a second nuclear species different from the first nuclear species.

17. The magnetic resonance imaging method as claimed in claim 11, wherein the first magnetic resonance signals are from a nuclear species other than the $^{1}$H nuclear species, and the second magnetic resonance signals are from the $^{1}$H nuclear species.

18. The magnetic resonance imaging method as claimed in claim 11, wherein the first magnetic resonance signals are from electron spins and the second magnetic resonance signals are from the $^{1}$H nuclear species.

## IX. EVIDENCE APPENDIX

The evidence was entered into the record by the Examiner in the first Office Action mailed January 22, 2007.

X. RELATED PROCEEDINGS APPENDIX

NONE